

CLAIMS

1. A method of displaying correlations among information objects, the method comprising:

receiving an information collection including information objects;

generating a visualization illustrating relationships between information objects and displaying visual information representing all information objects of the collection, the visualization being selected from a plurality of different available visualization types, wherein at least two of the visualization types can selectively be used simultaneously; and

selectively displaying visual information for a subset of information objects in response to a query.

2. A method of displaying correlations among information objects in accordance with claim 1 and further comprising selectively switching between visualization types so as to selectively display relationships within one information collection in multiple possible ways.

3. A method of displaying correlations among information objects in accordance with claim 1 wherein at least three different visualization types are available.

4. A method of displaying correlations among information objects in accordance with claim 1 wherein at least four different visualization types are available.

5. A method of displaying correlations among information objects in accordance with claim 1 wherein at least five different visualization types are available.

6. A method of displaying correlations among information objects, the method comprising:

receiving an information collection including information objects; and
generating a visualization representing relationships between the objects, the visualization being selected from at least six available visualization types including a type useful for demonstrating field/value pair co-occurrences, a type useful for demonstrating free-text similarity, a type useful for demonstrating temporal relationships, a type useful for demonstrating parent-child relationships, a type useful for demonstrating network relationships, and a type useful for demonstrating geospatial relationships.

7. A method of displaying correlations among information objects in accordance with claim 1 and further comprising selectively switching between visualization types so as to selectively display relationships within one information collection in multiple possible ways.

8. A method of displaying correlations among information objects in accordance with claim 6 and further comprising generating the visualization from information objects residing in separate databases.

9. A method of displaying correlations among information objects in accordance with claim 6 and further comprising generating the visualization from information objects of different types residing in separate databases.

10. A method of displaying correlations among information objects in accordance with claim 6 wherein two of the visualization types can be selectively displayed simulataneously.

11. A method of displaying correlations among information objects, the method comprising:

receiving a query against a database;

obtaining a query result set; and

generating a visualization, selected from a plurality of available visualization types, representing the components of the result set, the visualization including one of a plane and line to represent a data field, nodes representing data values, and links showing correlations among fields and values.

12. A method of displaying correlations among information objects in accordance with claim 11 and further comprising displaying labels, showing field names and data values.

13. A method of displaying correlations among information objects in accordance with claim 11 and further comprising using a plane for fields that are unordered, for the one of a plane and a line.

14. A method of displaying correlations among information objects in accordance with claim 11 and further comprising using a line for fields that are ordered, for the one of a plane and a line.

15. A method of displaying correlations among information objects in accordance with claim 11 wherein generating a visualization comprises displaying a lowermost plane that contains representations of information objects returned by the query and displaying at least one of a plane and a line above the lowermost plane that represent field members of the objects.

16. A method of displaying correlations among information objects in accordance with claim 11 and further comprising generating the visualization from information objects residing in separate databases.

17. A method of displaying correlations among information objects in accordance with claim 11 and further comprising generating the visualization from information objects of different types residing in separate databases.

18. A method of displaying correlations among information objects in accordance with claim 11 wherein a field value may be inspected by brushing over a node with a cursor.

19. A method of displaying correlations among information objects in accordance with claim 11 wherein the visualization is contained in a dialog box and wherein a field value may be inspected by opening a separate dialog box, the separate dialog box being configured to show all of the field values in the result set for a plane.

20. A method of displaying correlations among information objects in accordance with claim 11 wherein the visualization is contained in a dialog box and wherein a field value may be inspected by opening a separate dialog box, the separate dialog box being configured to show all of the field values in the result set for a plane.

21. A method of displaying correlations among information objects in accordance with claim 11 wherein, in response to a node being selected, at least one line is displayed that ties together all field and value pairs that are semantically associated with a pair represented by the selected node in combination with an associated at least one of a plane and a line.

22. A computer readable medium embodying computer program code which, when loaded in a computer, causes the computer, in operation, to:

- receive a query against a database;
- obtain a query result set; and
- generate a visualization, selected from a plurality of available visualization types, representing the components of the result set, the visualization including

one of a plane and line to represent a data field, nodes representing data values, and links showing correlations among fields and values.

23. A computer readable medium in accordance with claim 22 wherein the computer program code is further configured to cause the computer to display labels, show field names, and show data values.

24. A computer readable medium in accordance with claim 22 wherein the computer program code is further configured to cause the computer to use a plane for fields that are unordered, to define the one of a plane and a line.

25. A computer readable medium in accordance with claim 22 wherein the computer program code is further configured to cause the computer to use a line for fields that are ordered, to define the one of a plane and a line.

26. A computer readable medium in accordance with claim 22 wherein generating a visualization comprises displaying a lowermost plane that contains representations of information objects returned by the query and displaying at least one of a plane and a line above the lowermost plane that represent field members of the objects.

27. A computer readable medium in accordance with claim 22 wherein the computer program code is further configured to cause the computer to generate the visualization from information objects residing in separate databases.

28. A computer readable medium in accordance with claim 22 wherein the computer program code is further configured to cause the computer to generate the visualization from information objects of different types residing in separate databases.

29. A computer readable medium in accordance with claim 22 wherein a field value may be inspected by brushing over a node with a cursor.

30. A computer readable medium in accordance with claim 22 wherein the visualization is contained in a dialog box and wherein a field value may be inspected by opening a separate dialog box, the separate dialog box being configured to show all of the field values in the result set for a plane.

31. A computer readable medium in accordance with claim 22 wherein the visualization is contained in a dialog box and wherein a field value may be inspected by opening a separate dialog box, the separate dialog box being configured to show all of the field values in the result set for a plane.

32. A computer readable medium in accordance with claim 22 wherein, in response to a node being selected, at least one line is displayed that ties together all field and value pairs that are semantically associated with a pair represented by the selected node in combination with an associated at least one of a plane and a line.

33. A text visualization method comprising:

receiving vectors that characterize conceptual content of a plurality of text documents, each document being represented by a vector of arbitrary length; and

displaying a multi-dimensional representation of the document collection that conveys information about topics and subtopics described by the plurality of text documents, each document being represented by a multi-dimensional glyph, the displaying including sorting the glyphs into groups and arranging the groups into clusters such that clusters containing documents that are conceptually similar are located together in near proximity.

34. A method in accordance with claim 33 and further comprising color coding a glyph to convey information about properties of the document represented by that glyph.

35. A method in accordance with claim 33 and further comprising shape coding a glyph to convey information about properties of the document represented by that glyph.

36. A method in accordance with claim 33 and further comprising displaying labels for respective clusters, the labels including descriptive terms respectively generally describing the content of the clusters.

37. A method in accordance with claim 33 wherein the displaying comprises generating a three dimensional spatial representation for viewing on a generally two dimensional monitor.

38. A method in accordance with claim 37 and comprising, after arranging the groups into clusters, deriving centroids of clusters and down-projecting the centroids to three dimensions using multidimensional scaling (MDS).

39. A method in accordance with claim 38 and comprising, after deriving centroids of clusters and down-projecting the centroids to three dimensions, establishing a new local coordinate system at the location of each cluster centroid, scaled according to the number of vectors in the cluster, and downprojecting the document vectors within each cluster into these coordinate systems in isolation from the vectors contained in other clusters.

40. A method in accordance with claim 37 and comprising, after arranging the groups into clusters, deriving centroids of clusters and down-projecting the centroids to three dimensions using Sammon's Mapping.

41. A method in accordance with claim 40 and comprising, after deriving centroids of clusters and down-projecting the centroids to three-dimensions, establishing a new local coordinate system at the location of each cluster centroid, scaled according to the number of vectors in the cluster, and down-projecting the document vectors within each cluster into these coordinate systems in isolation from the vectors contained in other clusters.

42. A method in accordance with claim 33 wherein the displaying comprises using a neural network to organize the vectors.

43. A method in accordance with claim 33 and comprising mapping the vectors using a growing neural gas algorithm and determining the minimal spanning tree of nodes generated by the neural gas algorithm.

44. A text visualization method comprising:
generating vectors that characterize conceptual content of a plurality of text documents, each document being represented by a vector of arbitrary length; and
displaying a multi-dimensional representation of the document collection that conveys information about topics and subtopics described by the plurality of text documents, each document being represented by a multi-dimensional glyph, the glyphs being sorted into groups and the groups being arranged into clusters such that clusters containing documents that are conceptually similar are located together in near proximity.

45. A method in accordance with claim 44 and further comprising color coding a glyph to convey information about properties of the document represented by that glyph.

46. A method in accordance with claim 44 and further comprising shape coding a glyph to convey information about properties of the document represented by that glyph.

47. A method in accordance with claim 44 and further comprising displaying labels for respective clusters, the labels including descriptive terms respectively generally describing the content of the clusters.

48. A method in accordance with claim 44 wherein the displaying comprises generating a three dimensional spatial representation for viewing on a generally two dimensional monitor.

49. A method in accordance with claim 48 and comprising, after arranging the groups into clusters, deriving centroids of clusters and down-projecting the centroids to three dimensions using multidimensional scaling (MDS).

50. A method in accordance with claim 49 and comprising, after deriving centroids of clusters and down-projecting the centroids, establishing a new local coordinate system at the location of each cluster centroid, scaled according to the number of vectors in the cluster, and downprojecting the document vectors within each cluster into these nested coordinate systems in isolation from the vectors contained in other clusters.

51. A method in accordance with claim 48 and comprising, after arranging the groups into clusters, deriving centroids of clusters and down-projecting the centroids to three dimensions using Sammon's Mapping.

52. A method in accordance with claim 51 and comprising, after deriving centroids of clusters and down-projecting the centroids, establishing a new local coordinate system at the location of each cluster centroid, scaled according to the number of vectors in the cluster, and downprojecting the document vectors within each cluster into these nested coordinate systems in isolation from the vectors contained in other clusters.

53. A computer readable medium embodying computer program code which, when loaded in a computer, causes the computer, in operation, to:

receive vectors that characterize conceptual content of a plurality of text documents, each document being represented by a vector of arbitrary length; and

display a multi-dimensional representation of the document collection that conveys information about topics and subtopics described by the plurality of text documents, each document being represented by a multi-dimensional glyph, the displaying including sorting the glyphs into groups and arranging the groups into clusters such that clusters containing documents that are conceptually similar are located together in near proximity.

54. A computer readable medium in accordance with claim 53 wherein the computer program code is further configured to cause the computer to selectively color code a glyph to convey information about properties of the document represented by that glyph.

55. A computer readable medium in accordance with claim 53 wherein the computer program code is further configured to cause the computer to selectively shape code a glyph to convey information about properties of the document represented by that glyph.

56. A computer readable medium in accordance with claim 53 wherein the computer program code is further configured to cause the computer to display labels for respective clusters, the labels including descriptive terms respectively generally describing the content of the clusters.

57. A computer readable medium in accordance with claim 53 wherein the displaying comprises generating a three dimensional spatial representation for viewing on a generally two dimensional monitor.

58. A computer readable medium in accordance with claim 57 wherein the computer program code is further configured to, after arranging the groups into clusters, derive centroids of clusters and down-project the centroids to three dimensions using multidimensional scaling (MDS).

59. A computer readable medium in accordance with claim 58 wherein the computer program code is further configured to, after deriving centroids of clusters and down-projecting the centroids to three dimensions, establish a new local coordinate system at the location of each cluster centroid, scaled according to the number of vectors in the cluster, and downproject the document vectors within each cluster into these coordinate systems in isolation from the vectors contained in other clusters.

60. A computer readable medium in accordance with claim 57 wherein the computer program code is further configured to, after arranging the groups into clusters, derive centroids of clusters and down-project the centroids to three dimensions using Sammon's Mapping.

61. A computer readable medium in accordance with claim 60 wherein the computer program code is further configured to, after deriving centroids of clusters and down-projecting the centroids to three-dimensions, establish a new local coordinate system at the location of each cluster centroid, scaled according to the number of vectors in the cluster, and down-project the document vectors within each cluster into these coordinate systems in isolation from the vectors contained in other clusters.

62. A computer readable medium in accordance with claim 53 wherein the displaying comprises using a neural network to organize the vectors.

63. A computer readable medium in accordance with claim 53 wherein the computer program code is further configured to map the vectors using a growing neural gas algorithm and determine the minimal spanning tree of nodes generated by the neural gas algorithm.

64. A method comprising:

generating a graphical representation of an Internet directory structure, the Internet directory structure having characteristics, the generating including providing a shaded-relief terrain image as a visual metaphor for the Internet directory structure, the shaded-relief terrain image having characteristics representing the characteristics of the Internet directory structure.

65. A method in accordance with claim 64 wherein the Internet directory structure comprises a directory of Internet web sites.

66. A method in accordance with claim 64 and further comprising providing a user interface using which a user can interact with the terrain image.

67. A method in accordance with claim 66 wherein, using the user interface, a user is able to graphically browse web sites selected from web sites represented by the terrain image.

68. A method in accordance with claim 66 wherein, using the user interface, a user is able to perform a query of web sites represented by the terrain image.

69. A method in accordance with claim 66 wherein, using the user interface, a user is able to place bookmarks representing web sites of interest from web sites represented by the terrain image.

70. A method in accordance with claim 66 and further comprising providing a flag on the terrain image to indicate a bookmarked web site.

71. A method in accordance with claim 66 and further comprising providing a circle on the terrain image to indicate a query result.

72. A computer readable medium embodying computer program code which, when loaded in a computer, causes the computer, in operation, to:

generate a graphical representation of an Internet directory structure, the Internet directory structure having characteristics, the generating including providing a shaded-relief terrain image as a visual metaphor for the Internet directory structure, the shaded-relief terrain image having characteristics representing the characteristics of the Internet directory structure.

73. A computer readable medium in accordance with claim 72 wherein the Internet directory structure comprises a directory of Internet web sites.

74. A computer readable medium in accordance with claim 72 wherein the computer program code is further configured to providing a user interface using which a user can interact with the terrain image.

75. A computer readable medium in accordance with claim 74 wherein, using the user interface, a user is able to graphically browse web sites selected from web sites represented by the terrain image.

76. A computer readable medium in accordance with claim 74 wherein, using the user interface, a user is able to perform a query of web sites represented by the terrain image.

77. A computer readable medium in accordance with claim 74 wherein, using the user interface, a user is able to place bookmarks representing web sites of interest from web sites represented by the terrain image.

78. A computer readable medium in accordance with claim 74 wherein the computer program code is further configured to provide indicia on the terrain image to indicate a bookmarked web site.

79. A computer readable medium in accordance with claim 74 wherein the computer program code is further configured to providing indicia on the terrain image to indicate a query result.

80. A method of visualizing a hierarchy, the method comprising:
receiving a plurality of data records of a hierarchy that has a plurality of nodes, wherein a node includes at least zero data records and at least zero other nodes, the data records each including a field that identifies the position of the record in the hierarchy;

displaying a plurality of levels to represent the hierarchy, the displaying including displaying a glyph to represent a node of each branch of the hierarchy, radially arranging nodes that are at a common level in the hierarchy, and connecting nodes to portray hierarchical relationships; and

displaying records that terminate at a given node as glyphs arranged on a pan located beneath the node at which the records terminate.

81. A method of visualizing a hierarchy in accordance with claim 80 wherein a node having another node defines a subtree, the method further comprising lowering a first subtree relative to a second subtree when the first subtree is larger than the first subtree, the first and second subtrees being below a common node.

82. A method of visualizing a hierarchy in accordance with claim 80 and further comprising selectively labeling at least some of the nodes.

83. A method of visualizing a hierarchy in accordance with claim 80 wherein radially arranging nodes comprises selecting a radius depending on the number of nodes of be radially arranged.

84. A method of visualizing a hierarchy in accordance with claim 80 and further comprising color coding a glyph representing a record depending on a property of the record.

85. A method of visualizing a hierarchy in accordance with claim 80 and further comprising color coding a glyph representing a node depending on a property of the node.

86. A method of visualizing a hierarchy in accordance with claim 80 and further comprising shape coding a glyph representing a record depending on a property of the record.

87. A method of visualizing a hierarchy in accordance with claim 80 and further comprising shape coding a glyph representing a node depending on a property of the node.

88. A method of visualizing a hierarchy, the method comprising:

receiving a plurality of data records of a hierarchy that has a plurality of nodes, wherein a node includes at least zero data records and at least zero other nodes, wherein a node having another node defines a subtree, the data records each including a field that identifies the position of the record in the hierarchy; and

displaying a plurality of levels to represent the hierarchy, the displaying including displaying a glyph to represent a node of each branch of the hierarchy, radially arranging nodes that are at a common level in the hierarchy, and connecting nodes to portray hierarchical relationships, the displaying including lowering a first subtree relative to a second subtree when the first subtree is larger than the first subtree, the first and second subtrees being below a common node.

89. A method of visualizing a hierarchy in accordance with claim 88 and further comprising selectively labeling at least some of the nodes.

90. A method of visualizing a hierarchy in accordance with claim 88 wherein radially arranging nodes comprises selecting a radius depending on the number of nodes of be radially arranged.

91. A method of visualizing a hierarchy in accordance with claim 88 and further comprising selectively color coding a glyph.

92. A method of visualizing a hierarchy in accordance with claim 88 and further comprising selectively shape coding a glyph.

93. A computer readable medium embodying computer program code which, when loaded in a computer, causes the computer, in operation, to:

receive a plurality of data records of a hierarchy that has a plurality of nodes, wherein a node includes at least zero data records and at least zero other nodes, the data records each including a field that identifies the position of the record in the hierarchy;

display a plurality of levels to represent the hierarchy, the displaying including displaying a glyph to represent a node of each branch of the hierarchy, radially arranging nodes that are at a common level in the hierarchy, and connecting nodes to portray hierarchical relationships; and

display records that terminate at a given node as glyphs arranged on a pan located beneath the node at which the records terminate.

94. A computer readable medium in accordance with claim 93 wherein a node having another node defines a subtree, and wherein the computer program code is further configured to lower a first subtree relative to a second subtree when the first subtree is larger than the first subtree, the first and second subtrees being below a common node.

95. A computer readable medium in accordance with claim 93 wherein the computer program code is further configured to selectively label at least some of the nodes.

96. A computer readable medium in accordance with claim 93 wherein radially arranging nodes comprises selecting a radius depending on the number of nodes of be radially arranged.

97. A computer readable medium in accordance with claim 93 wherein the computer program code is further configured to selectively color code a glyph.

98. A computer readable medium in accordance with claim 93 wherein the computer program code is further configured to selectively shape code a glyph.